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THE TEACHING OF MATHEMATICS[1]

As mathematical pedagogy is receiving increasingly marked attention in this country, a brief account of the reforms recently proposed by Professor Felix Klein, of Germany, may be of general interest.[2]

The three types of German higher schools leading up to the university are the Gymnasium, the Real Gymnasium and the Ober Real Schule, corresponding roughly to the classical, Latin scientific and scientific courses in American high schools. Until recently, the university could only be entered through the portals of the gymnasium. This exclusive privilege might be termed the gymnasial monopoly, and even yet the gymnasium is the school of the aristocrat.

However, as a result of the Berlin Conference of 1900 and the emperor's decree of the same year, the three schools were placed on an equal footing and each per-

[1] Prepared by the author in connection with a course on the History and Teaching of Mathematics, given by Professor S. E. Slocum at the University of Cincinnati. For reports prepared by other members of the class see article soon to appear in the *Educational Review*.

[2] "Über eine zeitgemässe Umgestaltung des mathematischen Unterrichts an den höheren Schulen," F. Klein. "Bermerkungen im Anschluss an die Schulkonferenz von 1900," F. Klein. "Hundert Jahre mathematischer Unterricht an den höheren preussischen Schulen," F. Klein. "Über das Lehrziel im mathematischen Unterricht der höheren Lehranstalten," E. Götting. Collected in "Neue Beiträge zur Frage des mathematischen und physikalischen Unterrichts an den Höheren Schulen," Klein u. Riecke, Teubner, 1904.

mitted to work out its ideal along its own particular line, provided that the aim is to produce cultured citizens. Graduates of the Real Gymnasium and the Ober Real Schule, however, are debarred from the study of theology, and graduates of the latter are further debarred from the profession of medicine. In addition to the exclusive rights possessed by these three schools as feeders to the university, they also have the privilege of furnishing candidates for a majority of civil service positions.

After a three years' course in a Vorschule, or equivalent work done with private tutors, the average boy enters these schools at the age of nine, and may accomplish the work in nine years, being eighteen years of age when ready to enter the university; but so extensive is their study, and so closely are they held to their work, that the graduate of these schools is considered by many to be prepared to enter the junior year of our colleges.

This thoroughness of instruction is due to the fact that in Germany teaching is a profession, and is invested with all the dignity of custom and authority. The teacher must be a university graduate and a specialist in those subjects which he expects to teach. After having completed a three to five years' university course, a year is taken for the teachers' examinations. The applicant must qualify in at least four subjects (two major and two minor), and may teach only those subjects in which he has qualified.

His examination consists of two parts: written and oral. In the first he is assigned topics upon which to prepare theses, and is given six weeks to prepare each topic. His doctor's dissertation may be offered as one of these. If the written examination is satisfactory he is orally tested to determine his readiness in commanding his specialties. If successful, he is given a certificate from the examining board, which is composed of university professors.

After securing this certificate, a year's course in theoretical pedagogy must be taken at some seminar. Then follows the Probe-jahr, or year of trial teaching under criticism. If he is finally declared proficient, his name is placed on the service list, and he ultimately secures a position, sometimes waiting six or seven years for an appointment.

Adding the year of army service, the candidate is at least twenty-five years old (most of them are thirty) when placed on the list. Considering the thoroughness of preparation, and the depth of German scholarship, the statement that Germany has the best trained teachers in the world is, therefore, not surprising.

It should also be noted that all schools must come up to a certain definite standard. The government has a thorough system of inspection (as a matter of fact, too much bureaucracy), so that for a given type of school certain courses are uniform throughout.

For comparison the following outline of the course in mathematics in the Cassel Real Gymnasium is given. The period chosen corresponds most closely to that of the average American high school course.[3]

OBERSECUNDA (age, 15–16 years)

I. *Geometry and Trigonometry*, 3 hours.[4] Plane geometry and trigonometry re-

[3] The nine years of the German high school course, beginning at the lowest, are called, respectively, Sexta, Quinta, Quarta, Untertertia, Obertertia, Untersecunda, Obersecunda, Unterprima and Oberprima. See Russell's "German Higher Schools."

[4] Since 1901, forty-two week-hours are devoted to mathematics in the Real Gymnasium, a week-hour being one hour per week throughout the year.

viewed and concluded; solid geometry; practical applications.

II. *Arithmetic and Algebra,* 2 hours.

Arithmetical and geometrical series; compound interest and annuitics; quadratic equations; permutations and combinations; binomial theorem applied to positive integral exponents.

UNTERPRIMA (age, 16–17 years)

I. *Geometry and Trigonometry,* 3 hours.

Solid geometry continued; theory of plane and spherical angles; spherical trigonometry and its applications to mathematical geography; conic sections.

II. *Arithmetic and Algebra,* 2 hours.

Continued fractions and applications; arithmetical series of second order; cubic equations; problems in maxima and minima.

OBERPRIMA (age, 17–18 years)

I. *Geometry,* 3 hours.

Solid geometry reviewed and concluded; analytic geometry; problems in mathematical geography; geometrical drawing.

II. *Arithmetic and Algebra,* 2 hours.

Functions and applications to higher equations, especially those of the third degree; exponential, logarithmic, sine and cosine series; practical applications.

At the beginning of the nineteenth century those subjects whose development had been going on through the seventeenth and eighteenth centuries occupied the foreground in Germany, namely, Euclidean geometry; calculation with letters (Buchstabenrechnung); the theory of logarithms; the decimal system and the elements of analytic geometry. The elements of differential and integral calculus, although new, were also studied. The general tendency was toward the practical. Mensuration, elementary mechanics and those portions of descriptive geometry which dealt with fortifications occupied an important place. It is also noteworthy that a certain amount of mathematical knowledge was considered a prerequisite for philosophical learning, as witness the cases of Leibnitz and Kant.

Klein divides the nineteenth century into three periods. In the first period, extending from 1800 to 1870, mathematical instruction was a mixture of the pure and applied. Ideals were high, efforts were directed toward developing individual ability, and attempts were made to teach more than is now required. The candidate for the position of teacher of mathematics must be one who had gone as far as possible into the field, and was himself capable of original research. As the result we find such names as Grassmann, Kummer, Plücker, Weierstrass and Schellbach.

The second period, extending from 1870 to 1890, opened with the victory over France, and the assumption by Germany of a more important international position. This period seemed to be marked by the separation of pure, or abstract, and applied mathematics. In the schools the feeling prevailed that the development of the especially gifted pupil was not so much to be sought as that of the average pupil, and, consequently, greater interest was manifested in methods of instruction. A desire was expressed to replace the early system by a systematic graded course in mathematics, which should keep in view the ability of the constantly developing pupil. Drawings and models were demanded; problems were so stated and aids so given that pupils might see space relations, and not depend so largely upon the logic of the ancient Greeks. This was a direct result of the teachings of Pestalozzi and Herbart. In this period the teaching standard was lowered, as the teacher was only required to possess a knowledge sufficient to work out problems of moderate difficulty.

The third period, beginning with 1890, seems to be characterized by a tendency to again associate pure and applied mathematics; that is to say, the idea prevails that while a teacher should be thoroughly familiar with pure mathematics, his knowledge of its applications in the various fields should also be extensive. This is perhaps one result of the new order of things which puts the *real* schools on an equality as to privileges with the older gymnasium. There is also a tendency to allow the teacher greater freedom from the dictation of a centralized bureaucracy, and in this freedom lies an opportunity for future development.

For many decades, under the rule of the new humanism, the value of mathematical training was thought to lie in its formal discipline. Before the revival of learning it was the utilitarian factor which received emphasis, but in the last decades the majority have reached a more comprehensive view. Briefly stated, the modern view is that mathematical thought should be cherished in the schools in its fullest independence, its content being regulated in a measure by the other problems of the school; that is to say, its content should be such as to establish the liveliest possible connection with the various parts of the general culture which is typical of the school in question. Here, then, it is not a question of methods of teaching, but rather of the selection of material from the great mass furnished by elementary mathematics.

In the conference of 1900, it was agreed that each type of school should determine what form of culture its particular course should produce. It seems that the Gymnasium was asserting its claim to be considered preeminently the culture school, not hesitating to stigmatize the others as mere technical schools, while the friends of the Real schools apparently made no efforts at defense. Klein emphasized the fact that he considers the three schools of equal importance, and whatever he has to say concerns all three types.

Much of the material of instruction, although interesting in itself, lacks connection and is partially isolated. In fact, the topics seem for the most part to be the result of chance selection, and afford only a faulty and indirect preparation for a clear understanding of the mathematical element of modern culture. This element clearly rests on the idea of function and its form, both geometrical and analytical, and this idea should, therefore, be made the center of mathematical instruction. Klein's chief thesis is, in fact, that beginning with the Untersecunda and proceeding in regular, methodical steps, the geometrical concept of a function should permeate all mathematical instruction. In this is included a certain consideration of analytic geometry, and the elements of differential and integral calculus. He refers in this connection to two French publications which to a certain extent carry out his ideas.[5]

To accomplish this purpose, the graphical representation of the simplest elements, such as $y = ax + b$ and $y = 1/x$, should be begun in the Untersecunda. Trigonometry and the theory of algebraic equations furnish ample material for more complicated work, while in this connection related illustrations can be obtained from applications of mathematics, particularly from the domain of physics. Also the idea should be especially inculcated that a function can be developed empirically, perhaps by means of apparatus. In the Prima the general fundamental principles of both differential and integral calculus should be given, based upon the ideas which the pupil has acquired in the Secunda.

[5] "Notions de mathématique," Jules Tannery; "Algebra," E. Borel.

The ground to be covered depends largely upon the ideals of the school. Although the formal side must not be neglected and a thorough knowledge of processes must be obtained, the principal aim is to give a clear conception of the fundamental ideas and their meaning.

Much confusion often results from the fact that a word possesses several meanings. Thus a purist might define elementary mathematics as those parts of the subject in which the conception of a limit is avoided. The more commonly accepted definition of elementary mathematics, however, admits the idea of limits but excludes the special forms represented by the symbols dy/dx and $\int y dx$. Neither definition can be made to agree with the practise of the schools. For example, the first definition would exclude the consideration of such irrationals as $\sqrt{2}$, and π used in determining the area of a circle as the limit approached by a polygon. On the other hand, the second definition might be made to include much which does not belong in the schools, as, for example, the so-called "elementary" theory of analytic functions of the complex variable. The first definition might also be made to include much of the most difficult nature, such as advanced portions of the theory of numbers. In geometry there is also a new use of the word elementary. That portion of geometry is now styled elementary which is based on the Euclidean or ancient Greek geometry, the simplest conceptions of the newer geometry being of too severe a nature for the schools.

The only definition which will hold within the schools is a very practical one, namely, that shall be called elementary in the various branches of mathematics which can be grasped by the average pupil without extraordinary effort of long duration.

The material which constitutes elementary mathematics varies with time; that is to say, it is subject to the law of historical delay. Subjects which formerly were not considered elementary have, by improved processes of instruction, been made so, as is shown, for instance, in the geometry of the ancients. If, in consequence of the above definition, the extent of the field of elementary mathematics becomes too great and indeterminate, it comes within the province of the schools to choose those parts which best serve their purpose.

Mathematical instruction, on the level at which it is at present carried on in the upper classes of the higher schools, has existed in Germany since about the beginning of the eighteenth century. Christian Wolf, who was professor at Halle and one of the foremost schoolmen of this period, included in his list of elementary mathematics, in addition to the geometry of the ancients, a great many of what were at that time modern achievements, such as calculations with letters, negative numbers, algebraic equations and logarithms; in fact, practically everything which was known to mathematicians in 1700. It is evident that calculus was not included, for at that time the knowledge of calculus was the possession of only a few investigators of the highest type, whose efforts were not so much directed toward the clearing up of fundamental principles as toward the solution of new and difficult problems. To the layman, calculus seemed a sort of witchcraft. Cauchy's great work on differential and integral calculus appeared in 1821, but the schools had already been led into certain channels, and it was not possible to divert then toward a subject which was only in process of formation.

Moreover, it is true in general that mathematics is more susceptible than any other subject to hysteresis. A new idea finds its way into the schools through the lectures of university professors. A new

generation of teachers is thus trained who give the idea shape in their class work, until finally it becomes the common possession of all. In accordance with this process of development, Klein expresses his belief that it is now time to make the fundamentals of calculus a necessary part of elementary instruction. To illustrate the historical development of the subject, he quotes the words of his teacher of mathematics, who said in the fall of 1865, "In elementary mathematics we can prove things, but in the higher mathematics it is different. They resemble a philosophical system, which we may or may not believe." It is remarkable that this idea has completely disappeared in such a short interval.

For a long time calculus was regarded with distrust, but as it received recognition in the official course of study of 1900, Klein believes that it is time to take advantage of this favorable attitude to put that which has taken centuries for preparation upon a general and recognized basis. As a matter of fact the fundamental ideas underlying the calculus are actually taught in many schools. In a few Ober-Real schools they are regularly taught as calculus, but in the majority of the schools they are given in a very roundabout manner. It amounts to this, that students are actually taught to differentiate and integrate as soon as occasion for the same arises, but the terms differential and integral are avoided.

An inspection of the text-books in current use in the higher schools shows conclusively that many of the simpler ideas of calculus are in use, but are rendered more or less difficult of comprehension by the avoidance of symbols and operations, which, if understood, would render the work comparatively easy. If the field of physics were examined, instances of this kind would be greatly multiplied, especially in the fundamentals of mechanics and electrodynamics. Evidently, then, calculus occupies a more extensive field than is commonly supposed, but it is taught unsystematically, and is merely tacked on here and there to the general content of mathematical instruction. Klein is of the opinion that instead of making instruction in calculus in those grades whose work demands its employment merely incidental, desultory and generally unsatisfactory, it should be made the central idea of all instruction, and the other ideas and work grouped around it.

At present calculus is made the beginning of higher mathematics and is accompanied by a revolution in thinking. This revolution furnishes good evidence of the aimlessness of the earlier instruction as contrasted with the ideas with which the pupil later comes in contact. Klein's suggestion aims to spare the pupil this sudden change, by gradually accustoming him to the methods of thinking which prevail in his later work.

The traditional methods of teaching will readily accommodate themselves to this new idea, and in fact will be much simplified thereby. This statement is borne out by a comparison of the cumbrous algebraic method of solving problems with the methods of calculus. On the other hand, no harm is done if certain portions of mathematics which supposedly have merely a formal training value, such as artificial equations solved by quadratic roots, and trigonometric analysis, are pushed to the rear, for the new material gives ample opportunity for formal work.

The inadequacy of the present system is clearly shown in the education of the lawyer, physician or chemist. As regards the first two, it is, of course, understood at the outset that their work in mathematics must necessarily be brief, as their major subject allows little time for it. Hence

these students take up their major subject without preparation in calculus, with the result that some of the most important phases of their subject, depending upon higher mathematics, always remain obscure to them. This is true with lawyers, for instance, as regards questions of statistics, insurance, etc. With physicians the lack is felt at the very beginning of experimental physics, by reason of which instruction in the subject is necessarily placed on a much lower plane and the most important principles are only understood in a hazy way. It is still worse in chemistry, where quantitative determinations require the use of comparatively complicated formulas.

The text-books in these various subjects try to meet this situation with short prefaces on calculus, which the students are supposed to acquire in this condensed form. How then can the statement that calculus is too difficult for the higher schools be reconciled with the fact that students just released from the higher schools are expected to acquire this important subject from such condensed materials. Evidently conditions in the university emphasize the haziness of the aims of higher school mathematics.

Klein seems especially anxious to have it thoroughly understood that his plan is perfectly feasible, and comes well within the pedagogical possibilities of the case. In the first place, no more time is required than at present given to the mathematical curriculum. Moreover, he is not demanding a change in the course of study, but rather is urging that advantage be taken of the present leaning toward calculus, and carried out to its logical sequence. This, of course, can not be the work of a university professor, but must be that of the practical schoolmaster. The chief difficulty at present is that there are no text-books which fully meet the situation. Again, it is necessary to proceed with care and circumspection so as not to arouse the antagonism of the gymnasial leaders, but rather secure their friendly cooperation. There can be little opposition from the physicist if he is assured that there is no intention of invading his province, and it is pointed out to him that the pupils are being given tools for a far more complete mastery of his specialty. Neither should opposition be encountered from the representatives of the language and history departments if it is fully impressed upon their minds that the guiding principle of instruction should be the study of special subjects not as isolated from the rest of the curriculum, but with reference to the general culture which his particular type of school aims to produce.

The two main objections which are always urged when a university professor discusses educational problems of a general nature are that too little heed is given to pedagogical possibilities, and that university professors are only concerned about those pupils who will later come under their instruction. Concerning these objections, Klein answers the first by stating that he is keenly alive to the difficulty of the task of raising a large number of pupils, not especially gifted with mathematical ability, to a certain established level, and that his aim is not to raise this level, but rather to move it in what might be termed a horizontal direction.

As regards the second objection, he says that those pupils who take mathematics at the university are precisely the ones about whom he is not concerned, but that it is the future chemist, physician or lawyer whose mathematical training needs to be improved in order to bring about the best results.

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THE IDEAL UNIVERSITY ADMINISTRATION

The recent controversy in Syracuse University is one that is of far more importance to the educational interests of this country than a mere quarrel between two individuals. It is a symptom of a disease which to some extent is common in many universities, that is, the government of a university by a single autocrat, supported in power by a body of absentee trustees who are not educational experts. The time is ripe for a general study of the subject of university administration.

A university is primarily a congregation of students and teachers. The corporation responsible for the administration of the university may or may not be constituted wholly or partially of either students or teachers. The earliest university in Europe, that of Bologna, Italy, founded in the year 1119, was a corporation of students. The University of Paris, founded in 1200, was a corporation of teachers. Given a body of students of legal age, they might under our laws form a corporation, and it might hire a body of teachers, frame a set of by-laws, erect and furnish buildings and equipment, and so form a university. Or another body composed exclusively of teachers might form an organization, elect themselves as officers, issue stock, rent or erect buildings and furnish them, and advertise for students just as a mercantile house advertises for customers. A third method of making a university would be for a single rich man to furnish money, form a corporation with four dummy stockholders, giving them one share of stock each, erect buildings, provide the necessary equipment, hire teachers, advertise for students, and begin the business of furnishing education in exchange for tuition fees.

These three different corporations might each organize and carry on a university of the highest rank. These three universities may differ in many things; in age and reputation, in wealth, in numbers of professors and students, in social standing and in fame in athletics, in methods of teaching and in number of subjects taught, in systems of government and administration. One may have a magnificent campus and marble palaces, another no campus at all, but a lot of rented brick buildings in a city block, converted from old residences. They may differ in all these things, but in one thing they must agree, the possession of a corps of professors of the first rank. Given such a corps of professors and the students will come as a matter of course. The real university is the body of professors and students. The real work of the university is teaching. The buildings, the equipment, the system of administration, are the possessions, the appendages of the university, not the university itself. As the body is more than the raiment, as the inhabitants of a house are more than the house, as a man is more than his possessions, so is a university more than its mere equipment.

Given a real university, a body of capable, cultured gentlemen, able and willing to teach, a body of carefully selected students, able and willing to learn, a roof to cover them, the necessary equipment of furniture, apparatus and other material that modern methods of teaching require, what else does a university need to enable it to carry on its work?

First, money to keep it from going into bankruptcy. This may be furnished by the state, as is done in the west. The students may contribute a great deal of it, as in most eastern colleges. The professors contribute some by working for small salaries, getting the remainder of their income from interest on their investments or from doing outside work, and some is presented in the shape of contributions or legacies from philanthropic citi-

zens. The money is a mere detail. Good beggars may be hired on commission or salary to get enough of it to make up the annual deficits.

The next thing is a proper organization of departments. This the professors themselves, being educational experts, can easily provide.

Then there has to be provided a system of government. This will depend at first on the ideas of the originators of the university. We have assumed three universities, one started by students, one by teachers and one by a single rich man. They may all eventually by evolution reach the same best governmental system, or by degeneration the worst. The fittest may survive at last, but the unfit survives a long time. The United States has a splendid system of government, divided into legislative, executive and judicial departments, with mutual checks on one another, the result of the brains of Hamilton, Jefferson, Franklin and Washington. Old New England had an excellent system in its town meetings, but many of our states and cities are now suffering from bad government, the results of boss rule. So universities have not all reached the best type of government, and the existing type varies all the way from that of the chaos of mob rule to the rule of a czar. Mob rule is unstable, and never lasts very long. The boss soon appears and the rest of the mob become his puppets. The czar system is stable; it may last a thousand years, but it has fallen even in Persia, it is on the verge of falling in Russia, and it may fall within ten years in Turkey. The rule of the boss and that of the czar are not very different in results, although the czar rules by military force and the boss by the power of money.

The best system for a university is neither the boss nor the czar system, but the democratic system; not mob rule, but a carefully planned system of representative government, of which that of the United States is a model. It is founded on the principles of the Magna Charta and the Declaration of Independence. It involves the privileges of free speech, freedom of the press and trial by a jury of one's peers.

The object of a system of government, it has been said, is "to get things done." In organizing a good system of government there should be a carefully prepared list of the different things that are to be done and the best way of doing each should be considered. A mere suggestion of such a list is the following:

1. Determine the general policy of the university as to what departments of education it shall engage in.

2. Determine who shall have the appointing power of the executive officers of the government and who shall appoint professors and instructors.

3. Who shall be charged with the responsibility of raising money and who with the responsibility of spending it?

4. Who shall frame the constitution and by-laws and how and by whom shall they be amended?

5. The government of a university being like that of a nation, legislative, executive and judicial, where shall these different governmental powers be placed?

6. What procedure shall be followed in case any one has to make a complaint against a professor or instructor or other person holding office?

7. How shall a jury be constituted for his trial?

8. If the university is composed of several colleges, shall the general government of the university be managed by representatives from the colleges, or shall each college exercise only such power as may be allowed it from time to time by a central governing body or by an autocrat?

9. What rules shall be enacted concerning the discipline of students and who shall be entrusted with the enforcing of these rules?

10. What provision, if any, shall be made for calling in outside experts to advise in regard to improvements in educational methods, or what facilities shall be given to the professors to travel and study such methods?

The above list is not intended as a complete list, but is merely a suggestion as to the kind of questions that may arise in forming a university government.

The following is suggested as a form of organization which will best secure the desired result:

A board of trustees, the legal corporation, responsible for the financial management and for the enactment of broad legislation as to matters of general policy. It should contain men of wealth and social standing, to give it the prestige that such men can bring; men skilled in business and the law, to look after its invested funds; experienced educators, whose counsel may be valuable on matters of educational policy; representatives of each of the learned professions that has a college in the university; and representatives of the alumni of each college. Such a body of men under a proper system of government will not need to meet oftener than twice a year except in cases of emergency, nor will it need to take any active part in the details of management, but it would establish a set of rules delegating specific powers to another body of men better qualified than the trustees are to exercise them.

Such other body is a university senate or council, and it might be composed of, say, three trustees, who are willing to devote some time to university matters, of the deans of each college, ex-officio, of one professor from each college, elected for a definite period by its faculty, and of one alumnus of each college, not a trustee or holding any other position in the university, elected by the alumni association of each college.

This university council should be granted all powers not especially reserved by the board of trustees, and it may delegate such minor powers as it sees fit to the several deans or faculties.

The president or chancellor of the university should properly be elected by the trustees. He should represent the university on all public occasions. If he is an orator and money-getter, all the better; but whatever he is, it is not wise to give him autocratic power over the faculties nor over the council.

There might be a vice-chancellor, elected by the trustees on nomination of the council. It should be his duty to preside over the council, and to have a general oversight over educational matters, and he therefore should be an experienced educator.

Given two such bodies, each composed of strong men, and they could be trusted to discover the best system of university government and to frame it in a constitution and by-laws. Under such a government strong men could be obtained to fill the professors' chairs; they would be secure in their positions as long as they did their duty, and such a disgraceful proceeding as the one that has just taken place at Syracuse would be impossible.

William Kent

601 Comstock Ave.,
Syracuse, N. Y.,
June 9, 1908

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE

In a paper entitled "Cooperation in Scientific Bibliography" which appeared in Science, April 3, 1908, no mention was made of the work being done by the International Catalogue of Scientific Literature. As the

International Catalogue is undoubtedly the greatest of all cooperative bibliographical enterprises, it would not seem out of place to here briefly outline its present condition, its history having been sufficiently recorded in several papers by Dr. Cyrus Adler published in SCIENCE, August 6, 1897, June 2, 9, 1899, and August 28, 1903.

The first volumes of the International Catalogue dealt with the literature of 1901; since that date seventeen volumes have appeared annually, covering the whole field of science, classified under the following heads, each subject being the title of an annual volume: Mathematics, Mechanics, Physics, Chemistry, Astronomy, Meteorology (including Terrestrial Magnetism), Mineralogy (including Petrology and Crystallography), Geology, Geography (Mathematical and Physical), Paleontology, General Biology, Botany, Zoology, Anatomy, Anthropology, Physiology (including Experimental Psychology, Pharmacology and Experimental Pathology) and Bacteriology.

The aim of the International Catalogue is not only to cite the title of each scientific paper published since January 1, 1901; but to briefly supply an analytical digest of the subject of each paper. This is accomplished by means of classification schedules arranged to include in systematic order each minute subdivision or subject of all of the sciences named above. Not only was it necessary to provide in the schedules for the subjects of all previous scientific activities, but also to make ample and elastic provision for the present trend of scientific thought and investigation, and so far as possible to anticipate future need. It will be seen that such a broad system of classification must, to prevent its becoming unwieldy, be provided with some shorthand method of classifying the subject contents of scientific papers, not only for convenience in preparation, but for convenience in use. This has been successfully accomplished in the following manner: To each one of the sciences is assigned one of the letters of the alphabet, and to each of the subheadings in these sciences is assigned a number; in classifying the subject contents of any scientific paper instead of writing an abstract of the contents a letter and a number for each important subject treated is added to the citation, thus not only analyzing but classifying the author's work. The printed volumes are arranged first as author catalogues and second as subject catalogues. In the subject catalogues the classified references are assembled and grouped under each of the common heads to which they appertain, furnishing thereby a ready means of learning at a glance all that has been written on a given subject of scientific investigation. It will be seen that it is necessary for each paper to be examined by some one competent to appreciate its contents and note the salient points and principal subjects by means of the combined alphabetical and numerical method noted above.

The International Catalogue of Scientific Literature is more than an index, it is a condensed digest of the world's scientific literature.

As the editing and publishing of the International Catalogue is paid for entirely by the funds received from the subscribers, it has been necessary to charge $85 per annum for the complete set of seventeen annual volumes, although this sum has, up to the present time, barely been sufficient for the purpose intended. It is felt that the comparatively high price has greatly limited the sale of the catalogue and therefore limited its general usefulness, although no way can at present be seen to reduce the cost. Should a large endowment at any time be made for this work the general usefulness of the index could be extended by materially reducing the price of the volumes.

The organization of the catalogue is cooperative to the fullest extent; all of the nations of the world taking part in the work through the agencies of regional bureaus established in central locations in all of the principal countries of the world. These bureaus are supported by the countries in which they are established; in no case is any part of the subscription receipts used for their maintenance.

The Smithsonian Institution is and has

been, since the beginning of the undertaking, acting as the regional bureau for the United States and is, through the aid of a small governmental grant, collecting, indexing and classifying the scientific works published in this country. At the present time about thirty thousand classified references are being sent by the Smithsonian Institution each year to the London Central Bureau, and as the small congressional allotment only justifies the employment of a limited force to carry on the work this number represents practically the limit of the output of the bureau as at present constituted. The literature of each year since 1901 is gradually being filled in and when done will constitute a complete and permanent record of scientific work. That no paper of any importance might be omitted a most systematic routine is carried on of which a complete and permanent record is kept. For the regularly appearing periodicals a list of titles is kept and as soon as a number or part is indexed records are made of the fact, first under the title of the publication, then in an author's record, together with a complete copy of all data abstracted. By regularly going over these records any omission in a volume or part of a volume is apparent and the omission made good. For collecting books, pamphlets and separately appearing publications a variety of methods are resorted to; all the principal bibliographical lists are consulted, the *Publishers' Weekly* is regularly checked up, as are the following works: The Catalogue of Public Documents, proof sheets of the Library of Congress catalogue cards, the Experiment Station Record and various list of publications, such as those of the Carnegie Institution, the various colleges, the bureaus of the United States government.

The Smithsonian Institution is supposed to receive all scientific periodicals published in this country and its daily mail furnishes a great part of the material indexed. By means of these methods every published paper, coming within the scope of the catalogue, is almost certain at some time to come to the notice of the indexers for the catalogue. As similar or equivalent systems are used in the other regional bureaus in dealing with foreign scientific literature, it would appear difficult for any paper worthy of notice to escape this international drag-net now so systematically used to provide for the needs of the modern scientific investigator.

LEONARD C. GUNNELL,
SMITHSONIAN INSTITUTION,
WASHINGTON, D. C.,
June 11, 1908

THE INDIAN INSTITUTE OF SCIENCE[1]

AFTER negotiations and preparations extending over several years, the Indian Institute of Science is about to come into existence. Intelligence received by the last Indian mail states that Lord Minto, as patron of the institute, has appointed a provisional committee to conduct its affairs until the properties with which the institute is endowed can be vested in the constituted authorities. The committee has already met, and the construction of the institute buildings is to be commenced at once.

The institute owes its inception to the munificence of the late Mr. Jamsetji Nusserwanji Tata, a Parsi merchant and mill-owner of Bombay, who did much for the development of various Indian industries and started the scheme for the great iron and steel works now in course of erection at Sini. He wished to encourage the pursuit of science among young Indians, with special reference to the utilization of the country's resources, and thought the best plan would be the establishment of a large and well-equipped institution for post-graduate work. To this end he decided to allot a considerable portion of his ample fortune, in the shape of property at first calculated to produce Rs.125,000 (about £8,333) annually, though it is believed to have since appreciated in value. Unexpected difficulties were, however, experienced at the outset. Institutions of the kind in various parts of the world were first studied by special representatives, and it was sought to adapt their principal features to Indian requirements. Then the selection of a suitable site was a matter that took years

[1] From the London *Times*.

to decide. The city of Bombay was anxious to have the institute in its midst, or on the adjacent heights of Trombay, but experts advised that the climate was not suitable for delicate scientific work. Sir William Ramsay visited India, on the invitation of Mr. Tata, to assist him in his decision, and to advise concerning the character of the scheme. Professor Masson, of Melbourne, and Colonel Clibborn, Principal of Rurki College, prepared tentative plans and estimates. Ultimately, owing largely to the generosity of his Highness the Maharajah of Mysore, it was decided to build the institute at Bangalore, which has an agreeable and temperate climate. The Maharajah, on the advice of his late enlightened Dewan, Sir Seshadri Iyer, not only offered free a valuable site half a mile square for the institute and its grounds, but agreed to make an annual grant of Rs.50,000 (about £3,333) towards its maintenance. The cooperation of the government of India was an essential feature of the scheme. It was always recognized that the liberal provision offered by Mr. Tata would not, even with the aid of the Mysore grant, suffice for the cost of upkeep. The government was therefore asked to make an annual contribution. So long has the scheme been under consideration that almost the first duty undertaken by Lord Curzon on his arrival in India as Viceroy was a discussion of the matter with an influential deputation. Eventually the annual grant of the government of India was fixed at Rs.87,500 (about £5,833). Before the transfer of the property was completed Mr. Tata died somewhat suddenly at Nauheim. His two sons, who were his heirs, immediately announced their decision to carry out their father's wishes. As the property was in real estate, there were interminable legal delays, but these are now at an end. The cost of the buildings and equipment had, however, still to be provided. Towards this purpose the government of India has contributed Rs.250,000 (about £16,666), and the Maharajah of Mysore Rs.500,000 (about £33,333). The building is expected to cost Rs.1,100,000 (about £73,333), and the balance will be obtained from the surplus income already accumulated. By the late Mr. Tata's express wish, his name will not be associated with the institute.

On the advice of Sir William Ramsay, Dr. Morris W. Travers, F.R.S., who was formerly on the staff of University College, Bristol, was appointed director of the institute, and arrived in India about eighteen months ago. He has since been busily engaged in work connected with the undertaking, which is now primarily under his control. Sir Herbert Risley, on behalf of the government of India, has been closely associated with the various stages of development. Some members of the staff have been already appointed and have taken up residence at Bangalore. The site of the institute is about three miles from the center of the station, and is 3,080 feet above sea-level. It commands a view of one of the most beautiful pieces of undulating country in southern India, and the Maharajah has ceded jurisdiction over the site to the imperial government. The architect selected is Mr. Charles F. Stevens, whose father designed the Victoria terminus at Bombay and many other famous buildings in India.

The chief work of the institute will be the establishment of departments of pure and applied science, and students who have passed through the Indian universities will be trained so that they may apply science to the Indian arts and industries. It will be in no sense a "trade school." Though there will be no undergraduate side at present, it is expected that this may ultimately become a necessity, as has been the case with some post-graduate institutions in America. Even as it is, most of the Indian students entering the institute will first have to go through a course of practical instruction before commencing research. Private workers requiring accommodation for the purpose of investigating new products or processes, or actuated by a desire to carry out scientific research, will be received. Six departments are to be established, each with a professor and assistant professors. The director will occupy the chair of pure chemistry, and a professor of applied chemistry has

already been selected. In view of the importance of vegetable products in India, there will also be a chair of organic chemistry. The nearness of the great Cauvery power works, from which a supply of electricity at high tension will be obtained, has led to the decision to open a department of electrical technology. There will also be a chair of bacteriology, and, though the sixth department has not yet been finally decided on, it may be a chair of metallurgy or electro-metallurgy. A large sum is being allotted for the creation of a library. Probably sixty students will be admitted to the institute in the first two or three years, and a few students in chemistry may be at work by the end of the present year, when temporary laboratories will become available.

The question of suitable openings for students of the institute causes no anxiety among those responsible for its direction. It is believed that the supply of well-trained scientific men will create a demand. There is already a certain demand in India for chemists in sugar works and similar concerns, and also for analysts in metallurgical enterprises. The demand for electrical engineers is growing rapidly. Dr. Travers states, however, that "it is not so much in industries which are already flourishing, but in nascent industries."

THE ORDER OF THE CONTENTS OF "SCIENCE"

With the present issue of Science, which opens the twenty-eighth volume of the new series and the fifty-first volume of the journal, a change is made in the arrangement of the contents. It may be explained that this is done in order that the number may be paged more quickly and conveniently. To fill the pages exactly certain of the items under "Scientific Notes and News" must be adjusted to fit. When these notes are at the end of the number, it must be paged until they are reached. Placing them in the middle of the number permits making up the forms by starting at the same time from the beginning and the end. The proceedings of Scientific Societies and Academies, which will hereafter be placed at the close of the number, will be printed in smaller type, in order that this department may represent as completely as possible the increasing activity of the scientific societies of the country. Finally, this opportunity may be used to remind subscribers that those who wish to receive their copies of Science with the pages trimmed should write to the publishers to that effect.

SCIENTIFIC NOTES AND NEWS

Dr. Adolf Meyer, director of the Pathological Institute of the New York State Hospitals, has accepted a professorship of psychiatry in the medical department of the Johns Hopkins University, and the directorship of the Psychiatric Hospital and Clinic, recently founded by Mr. Henry Phipps.

Harvard University has conferred its doctorate of laws on Dr. Charles R. Van Hise, president of the University of Wisconsin, and its doctorate of science on Dr. W. C. Gorgas, member of the Isthmian Canal Commission and this year president of the American Medical Association.

The University of Wisconsin has conferred its doctorate of laws on Professor Calvin M. Woodward, dean of the School of Engineering of Washington University, St. Louis, and on Dr. Frederick Belding Power, director of the Wellcome Research Laboratory, London, and formerly professor of pharmacology in the University of Wisconsin.

Yale University has conferred its doctorate of science on Dr. Graham Lusk, professor of physiology in the University and Bellevue Hospital Medical School, New York, and formerly professor in Yale University.

Amherst College has conferred its doctorate of laws on William Bullock Clark, professor of geology in the Johns Hopkins University.

Trinity College has conferred its doctorate of laws on Dr. James Ewing Mears, professor in the Jefferson Medical College, Philadelphia, and its doctorate of science on Dr. Andrew Ellicott Douglass, professor of physics and astronomy in the University of Arizona, and on

Dr. C. C. Trowbridge, instructor in physics in Columbia University.

THE Albert medal of the Royal Society of Arts has been awarded to Sir James Dewar.

SIR WILLIAM RAMSAY succeeds Lord Kelvin as a member of the Dutch Academy at Amsterdam.

DR. WILHELM PFEFFER, professor of botany at Berlin, has been made a knight, and Dr. H. Lorentz, professor of physics at the University of Leyden, a foreign knight, of the Prussian order of merit.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has been appointed United States representative on the international commission to investigate the fishery laws governing the American-Canadian border waters. He has gone to Eastport, Me., to meet the British commissioner.

AT the May meeting of the American Academy of Arts and Sciences, held at Boston, Professor John Trowbridge was elected president, and Professor Edward H. Hall, corresponding secretary.

DR. WILLIAM H. HOWELL, dean of the medical faculty of the Johns Hopkins University, delivered the address to the graduating class of Jefferson Medical College, Philadelphia, at the annual commencement.

PROFESSOR ARMIN O. LEUSCHNER, director of the Students' Observatory of the University of California, has been granted his sabbatical leave for the next academic year. He leaves Berkeley in June to visit some of the eastern observatories before going abroad. His time will be divided principally between Berlin and Paris. For the year of his absence the Berkeley astronomical department will be in charge of Assistant Professor R. T. Crawford as acting director.

DR. J. CULVER HARTZELL, professor of chemical geology, University of the Pacific, will spend six weeks in a study of the metamorphic rocks of the Santa Lucia Range about the Big Sur region.

THE University of Chicago will send a paleontological expedition to the Permian of Texas during the present season under the charge of Mr. Paul Miller.

THE death is announced of Dr. Chamberland, sub-director of the Pasteur Institute, author of papers on anthrax, drinking water and epidemic diseases and other subjects.

DR. OSTWALD SEELIGER, professor of zoology at Rostock, has died at the age of fifty years.

DR. A. A. BAER, medical superintendent of Prisons, Berlin, and author of numerous writings on the hygiene of prisons, on criminals, on alcohol in relation to crime, etc., has died, aged 74.

THE minister for agriculture of New South Wales, Australia, desires applications for the position of pathologist in his department. The salary will be six hundred pounds with yearly increments of twenty pounds, until the sum of seven hundred pounds is reached. The position is that formerly held by Dr. N. A. Cobb. Further information may be had by applying to Dr. Cobb, whose present address is Department of Agriculture, Washington, D. C. The applications are due in Sydney, New South Wales, on August 4, 1908.

THE Everhart Museum of Science and Natural History, a gift of Dr. Isaiah F. Everhart, was dedicated and presented to the city of Scranton with fitting ceremonies on May 30. Dr. Everhart has endowed the institution with a fund of $100,000.

THE New England Federation of Natural History Societies will hold a field meeting on the summit of Mount Washington during the week from July 1 to 8. The gathering will include representatives of about twenty societies and will be particularly strong in botanical members. The members of the geological section of the American Association will join the party at the summit at the conclusion of the meeting at Hanover.

THE Council of the Association of American Geographers has decided to hold its next annual meeting at Baltimore, in affiliation with the American Association for the Advancement of Science. The exact dates of the meeting will be announced later.

THE semi-annual meeting of the American Society of Mechanical Engineers was held

in Detroit, Mich., from June 23 to 26. A session was devoted to papers on the conveyance of materials, hoisting and conveying machinery including belt conveyors, the use of conveying machinery in cement plants, etc., being discussed. The Gas Power Section of the society held a session, and the Society for the Promotion of Engineering Education and the Society of Automobile Engineers held a meeting in Detroit at the same time.

The twenty-fourth Congress of the Royal Sanitary Institute will be held at Cardiff on July 13 to 18, under the presidency of the Earl of Plymouth.

The results of a poll taken by the Geological Society, London, to ascertain the opinion of the fellows resident in the United Kingdom as to the admission of women to the society have been announced. The number of voting papers sent out was 870, and 477 replies were received. Two hundred and forty-eight fellows were in favor of the admission of women as fellows and 217 against their admission, but of this number 84 were in favor of their admission as associates.

On June 1 the Grand Duke Michael opened the International Congress on Navigation, which is being held for the first time in St. Petersburg.

The Second International Anatomical Congress will be held at Brussels, Belgium, in 1910, in accordance with a decision reached by the international committee at a meeting held during the session of the *Anatomische Gesellschaft* at Berlin. The exact date of the congress has not yet been fixed, but the probable date is the latter part of August or early in September. Brussels offers many advantages for such a congress, and the city has an established reputation for its hospitality towards scientific guests. It is hoped that there will be a considerable attendance from America, and early notice of the proposed congress is therefore issued that American anatomists may plan so as to be able to participate in it. The development of anatomical science in this country has been so rapid that we now have a large number of persons actively engaged in scientific research, and there ought to be a large American delegation in attendance at the congress.

The steam-yacht *Nimrod,* which took Lieutenant Shackleton's party to the Antarctic, and which returned to New Zealand some months ago, is lying at Lyttleton, the expedition's headquarters. Captain England, who took the *Nimrod* down to King Edward the Seventh Land, has resigned from his command, and has gone to the United Kingdom. The arrangement was that the *Nimrod* should make a magnetic survey of New Zealand waters until she was ready to go to the Antarctic again in December, 1908, to bring back Lieutenant Shackleton and his comrades, but as no commander has yet been appointed in Captain England's place, that arrangement has been abandoned. Professor David, of Sydney, at the last moment, decided to accompany Lieutenant Shackelton. In a private letter, sent by the *Nimrod,* after leaving the party at its headquarters near Mount Erebus, Professor David states that he expects to be back in New Zealand by April, 1909, when the whole party will return.

The Danish explorer, Captain Ejnar Mikkelsen, has returned to Copenhagen after his two years' sojourn in the regions north of Alaska. According to his statements in the Copenhagen papers, as summarized in the London *Times,* the expedition proved a success, and the scientific investigations were of value. He hopes to be able to continue the work next year. The chief object of the expedition was to decide whether there is land to the north of Alaska or a deep sea. Captain Mikkelsen's ship, the *Duchess of Bedford,* arrived on September 17, 1906, at Flaxman Island, where she was soon frozen in. The whole of that autumn was spent in mapping the surrounding country and observing the tide. About 40 miles from the coast the party found mountains from 10,000 feet to 12,000 feet in height, hitherto not marked on any map, and Mr. Leffingwell, the companion of Mr. Mikkelsen, undertook some geological researches. In March, 1907, Captain Mikkelsen, Mr. Leffingwell, and the mate of the Duchess of Bedford, a Norwegian named

Storkersen, started in three sledges with 18 dogs on a trip over the ice towards the north. The thermometer showed 56 degrees Centigrade below zero; nevertheless, they often came across big crevices among the ice floes. About 50 miles from shore they found water which they sounded with a newly-invented machine to the depth of 800 meters without reaching bottom. Sixty miles farther on no change was recorded, until at last, turning towards the southeast, they found bottom. They followed this edge of the continental shelf towards the east, but had soon to return owing to the strong current. Captain Mikkelsen was thus able to prove that deep water exists north of Alaska to a great distance. On the return journey the ice had started drifting and thick fogs enveloped everything, but on May 13, after 55 days of sledge journey, the explorers reached land again, only to find that the ship had been lost in the meantime. The ice pressure had proved too much for her, but the crew had saved all the instruments, food and utensils.

UNIVERSITY AND EDUCATIONAL NEWS

THE class of '83 of Harvard University will present to the university for its general endowment a fund of more than $100,000.

BY the will of George Bliss Griggs, who graduated from Yale University in 1872 and who died on May 22, Yale is bequeathed a fund of $75,000, to be used to found scholarships for worthy students in the academic department.

BY the will of Colonel C. S. Barrett, of Cleveland, O., a member of the class of '63 of Norwich University, the institution receives an unrestricted endowment of $100,000.

THE contract has been let for a new agricultural building for the University of Missouri which will cost $100,000. This building will contain the administrative offices of the College of Agriculture and Experiment Station, and will house also the departments of animal husbandry and agronomy and the State Soil Survey. It will likewise house the State Board of Agriculture, including the offices of the state veterinarian, the state highway commissioner and the pure food and dairy commissioner. The building is to be of native limestone, two stories and a high basement, with an extreme length of 266 feet. It will be thoroughly fireproof, and is to be completed by the middle of the next school year.

THE trustees of the Massachusetts College of Agriculture and the Mechanic Arts at Amherst have voted to establish a graduate school with Professor Charles H. Fernald as its head. It will confer the degrees of master of science and doctor of philosophy.

PROFESSOR C. H. BEACH, of the University of Vermont, has been elected president of the Connecticut College of Agriculture and Mechanic Arts. Professor Beach is succeeded in the chair of animal husbandry at Vermont by Mr. Robert M. Washburn, state dairy and food commissioner of Missouri.

THE following appointments, to take effect in August, 1908, have been made in Stanford University: John Andrew Bergström, of Indiana University, to be professor of education; Burt Estes Howard, of Los Angeles, to be professor of political science; J. E. McClelland, to be assistant professor of mining; John Kester Bonnell, to be instructor in English; F. O. Ellenwood, to be instructor in mechanical engineering; Robert E. Richardson, to be instructor in bionomics; L. Lance Burlingame, to be instructor in botany. The following promotions have been made: Allyn Abbott Young, from associate professor to be professor of economics; Frederick John Rogers, from assistant professor to associate professor of physics; Wesley Newcomb Hohfeld, from assistant professor to associate professor of law; Henry Waldgrave Stuart, from assistant professor to associate professor of philosophy; Charles Andrew Huston, from instructor to be assistant professor of law; Edwin Chapin Starks, from curator to be assistant professor of zoology; Samuel B. Charters, Jr., from instructor to be assistant professor of electrical engineering; Everett P. Lesley, from instructor to be assistant professor of mechanical engineering; George Holland Sabine, from instructor to be assistant professor of philosophy; Robert B. Harshe,

from instructor to be assistant professor of graphic arts.

The following promotions have been made at Lehigh University: L. D. Conkling becomes assistant professor of civil engineering; S. S. Seyfert, assistant professor of electrical engineering; A. W. Klein, assistant professor of mechanical engineering; Joseph Daniels, assistant professor of mining engineering; J. W. Miller, assistant professor of mathematics; J. E. Stocker, assistant professor of mathematics and astronomy; F. R. Ingalsbe, assistant professor of geology; C. S. Fox, assistant professor of modern languages. In the department of chemistry D. J. McAdam, Jr., has been promoted from assistant in chemistry to instructor in physical chemistry and qualitative analysis; F. S. Beattie from instructor in chemistry to instructor in industrial chemistry and qualitative analysis.

DISCUSSION AND CORRESPONDENCE

THE AMERICAN SOCIETY OF NATURALISTS

To the Editor of Science: As secretary of the American Society of Naturalists it has recently been necessary for me to become more familiar with the organization and relations of this society and to face its problems from a new point of view, especially in connection with arrangements for a program for the next meeting in December.

Some of my suggestions will probably be benefitted by discussion and, hence, should be published in advance of the meeting. I am aware that this matter was brought up in Chicago some years ago, but as action is still delayed I shall try to formulate the problem concisely in the hope of securing the attention of the society.

The recent publication of the program of the American Association for the Advancement of Science for a Darwin celebration shows most clearly how urgent this problem is. Here arrangements, peculiarly the province of the naturalists, have been perfected without consulting their official representatives! Speakers have been engaged and dates set which may conflict seriously with the plans of the Society of Naturalists now maturing. Yet the American Association evidently desires to foster biological interests in undertaking such an extensive and appropriate program. The difficulty lies in the faulty organization of the naturalists! I have accidentally learned of a Darwinian celebration to be held about the same time under the auspices of the botanists. Other affiliated societies have not been heard from. Such lack of an organized cooperation between these societies must generally bring about diffuse results with more or less duplication or conflict. In this case, though each of the three or more Darwinian celebrations will probably prove to be well worth while, a proper recognition of the Society of Naturalists, as a primary natural division of the American Association, would have secured immediately a well-balanced correlation of effort resulting in a single celebration, even more effectively organized and representative. If, however, the society is to be thought of as a division of the American Association, it must be conceded the power of initiating and controlling action relating to the Naturalists.

The plan of organization for the Society of Naturalists, suggested below, would not merge it with any other society nor destroy its individuality, as has been feared at times would happen; on the contrary, it should gain a more dignified position, and its usefulness would be more generally recognized.

The following is my idea:

1. The Society of Naturalists is largely made up of members of affiliated societies, and still represents a real cooperation between these related special interests which have developed since its foundation. This cooperation should be maintained and extended by an effective organization.

2. The activity of this society, however, is now practically restricted to an annual dinner and to an annual discussion, though it makes occasional and irregular attempts at united effort when some common cause must be advanced, as, for instance, cooperation in biological investigation and teaching, or the dealing with educational, sociological or health problems, involving a national effort of the biological societies.

3. The group of societies forming the naturalists constitutes a great natural subdivision of the American Association for the Advancement of Science, representing a definite phase of the work and aims of this general society, but in no sense subordinate to it. The American Association should act for the Naturalists where its aid is demanded, but the relations of the two societies must be so adjusted that there shall be no danger of encroachment on the dignity, powers or functions of the Naturalists. The broader society can obtain good results only by a generous attitude of service to its coordinated sections.

4. The Society of Naturalists should then be preserved as an important group, but in a modified form.

5. The organization of the society should be made more representative and efficient by including all of the members of all affiliated societies. It should not then be restricted, from chiefly accidental causes, to a special list of names. As a matter of fact all naturalists are welcomed and actually take part in its dinners, discussions, etc. They should then be recognized as members. At present even a few of the officers of some of the affiliated societies are not rated as members of the naturalists.

6. The naturalists should appoint a committee to bring about a new coordination between their affiliated societies and also to secure a proper adjustment with the American Association for the Advancement of Science.

7. As soon as the affiliated societies will take this necessary action to place the Society of Naturalists on the footing it should occupy, the membership should be as follows: The membership of the society should still be published, but, since identical with that of its affiliated societies, by simply giving the titles of these societies, and referring to their lists and that of the American Association for addresses, etc. A few who are members of the naturalists, but not of the affiliated societies, should, of course, be added. In addition there should be a statement of the constitution, aims and acts of the society and its function of organizing cooperation in biological undertakings where combined action is desirable, should be clearly formulated and recognized.

8. The Society of Naturalists should no longer be obliged to collect dues, except from members not belonging to the affiliated societies. Even with its annual fee of one dollar it does not now receive the amount which should come to it under a different organization.

9. The affiliated societies should collect a small annual fee in addition to their own, to be devoted to the purposes of the Society of Naturalists, thus recognizing its usefulness. This would probably give a larger annual total than is now collected from its restricted membership.

10. The society should make the *American Naturalist* its official organ, and this journal should set aside special sections for the publication of articles and discussions bearing on the problems of the society. Dr. McMurrich, the late president of the society, has recently (see SCIENCE, March 5, 1908), pointed out in an able manner advisable lines for future development. He has also well expressed the feeling of many members that this society is an important factor in the scientific and educational development of this country, and the above suggestions are not intended to conflict in any way with the common desire that the society shall continue to remain independent, even though a readjustment of its external relations shall permit a more effective cooperation.

H. McE. KNOWER
Secretary to the American Society of Naturalists

NEWS FROM KILAUEA

THIS volcano is now in action. Since 1894 there has been no exhibition at all comparable with that now apparent. Hon. L. A. Thurston, than whom there is no better judge of the conditions, writes as follows to the *Advertiser* issued May 29:

Within the last few weeks the central pit has filled up by the rising of molten lava within its walls until its floor is now only about 200 feet below the floor of the main crater.

At this level, 200 feet below the spectator,

there is a lake of molten lava, in the shape of the figure eight, approximately 800 feet long by 400 feet wide. Near the center of the northern lobe of the lake is an island some 78 feet in length, in the shape of a half moon. Within the little bay formed by the points of this island there is an almost constant boiling of the molten lava, with explosive bursts of gas every minute or so, which throws masses of the molten fluid into the air some 30 to 40 feet, and scatters it over an area of approximately 100 feet in diameter. Immediately after each outburst of gas a tremendous suction draws the lava from a radius of 100 feet of the bay into a vortex like that of a maelstrom, great cakes of lava 15 or 20 feet in diameter being turned up on edge, sucked in and disappearing like chips down a whirlpool.

Immediately north of the island, at a distance of not more than 100 feet therefrom, there is a gigantic outpouring of lava from beneath, without any bubbles or explosions. It looks like an enormous spring, the lava simply welling up and flowing off in all directions. The current is so rapid that the surface of the lake does not have time to cool, except in spots, and these spots are at frequent intervals upheaved by convulsions from beneath, and the black crust engulfed in the liquid lava beneath. The crusts striking the banks of the lake, which are from four to six feet high, are either shoved bodily upon the banks, like ice cakes in the Arctic, or upturned on edge and swallowed up in the fiery depths below. At intervals boiling spots appear at various points on the lake; engulfing the black cakes of lava floating thereon. The outpouring of the lava from the great spring is so great that the level of the liquid lava is raised faster than the surrounding banks can retain it, and at frequent intervals the banks give way and torrents of lava flow out into the surrounding territory in the pit, until that portion of the pit is raised to a level that stems the flood.

This action has been going on now for several weeks, the lake constantly enlarging and the floor of the pit being raised by the overflows of lava.

The brilliancy of action can be judged from the fact that a lantern is not needed in crossing the rough floor of the crater, the light from the lake being more than sufficient to show the trail in its details. The glare of the lake can also be seen any clear night from Hilo and Honuapo, at distances of 31 and 35 miles, respectively.

The probability is that this brilliant display can be seen for several weeks or months yet; but it would be well for visitors to lose no time in starting for the volcano for fear of disappointment. It will be many years before another equally good opportunity is likely to present itself.

C. H. Hitchcock

Hanover, N. H.,
June 10, 1908

SCIENTIFIC BOOKS

Air-ships, Past and Present. By A. Hildebrandt. Translated by W. H. Story. Pp. 364; 222 illustrations. New York, D. Van Nostrand & Co. Price, $3.50 net.

There have been hitherto few satisfactory books in English upon aerial navigation and information in newspapers has not always proved accurate. We now have, however, a book by a thorough expert, Captain Hildebrandt, instructor in the Prussian Balloon Corps, who wrote the work in 1906, and it was found so good as to warrant translating into English by Mr. W. H. Story. There are twenty-six chapters and profuse illustrations.

The greater portion of the book is naturally devoted to balloons. These vessels have now been developed to almost adequate speed and efficiency in the "dirigible air-ships" of the present day and the European nations are providing themselves with war aerial navies which are described and illustrated by Captain Hildebrandt, in a popular way so as not to repel untechnical readers.

He begins with the early history of the art, this referring chiefly to flying machines, and then gives two chapters to the hot-air balloon and its subsequent supersession by the hydrogen balloon. In the fourth chapter the theory of its flotation is taken up and formulæ are given for calculating the "lift" at different heights, or with different atmospheric pressures. Also for the effects of temperature upon the enclosed gas. Then four chapters contain the history of the dirigible balloon, with copious illustrations of the vessels which have marked the gradual increase in speed. This was twenty-two miles an hour for the French "Lebaudy" in 1906. Since then it has been increased by increased sizes to about thirty miles an hour, which must be very near

the limit and will probably enable such craft to cruise about three quarters of the days of the year. A misprint on page 63 states the length of the German "Zeppelin" as 85 feet instead of 414 feet.

A rather scant chapter follows on flying machines, but it can be profitably studied to ascertain the various steps which have led to the success of the last two years.

After devoting one chapter to kites and another to parachutes, both of which are fairly well written, the author passes to military ballooning, in which he is evidently thoroughly proficient. He takes up its development, describes its uses in the Franco-Prussian war, and then devotes two chapters, the ablest in the book, to the modern organization of military ballooning in some fourteen different countries. This brings us to chapter XVI., Balloon Construction and the Preparation of the Gas, followed by one on Instruments, and then follows Ballooning as a Sport, in which the author is evidently an adept, having made many such expeditions and relating them in an entertaining way.

Chapter XIX., on Scientific Ballooning describes the various journeys (in some of which the scientists lost their lives) made to ascertain the laws of decrease of air pressure, of temperature changes, of saturation, of the composition of the air, of its electrical and its acoustical properties. The greatest authentic height attained by man has been 35,500 feet, while kites have been flown to 21,100 feet and unmounted balloons with recording instruments (ballons-sondes), have reached 85,000 feet (16.1 miles) and have furnished data which will presently be utilized in foretelling the weather.

The next six chapters treat of balloon photography, of the outfit required, of the interpretation of photographs, of the uses of kites and of the methods for interpreting the bird's-eye views obtained for topographical purposes, in all of which the author is evidently an expert. He has also had much experience with carrier pigeons and devotes a chapter to them. The reader may be surprised at the statement quoted that the mean speed of these birds is only about 26 miles an hour; feats mentioned in sporting books having been probably accomplished by the aid of the wind. Swallows fly faster than pigeons, but efforts to train them have failed so far.

The last chapter is on Balloon Law. The author states that such law can hardly be said to exist, but "that some sort of international regulation will be necessary in the future, seeing that balloons are now much more common than they were and that the dirigible air-ship is a practicable possibility."

The book is well written and well translated. Its perusal will enable the reader to follow understandingly the great advances since 1906 which are now in process of evolution.

O. CHANUTE

CHICAGO, ILL.

Laboratory Exercises in Physical Chemistry. By FREDERICK H. GETMAN, Ph.D. Second Edition. Pp. x + 285. New York, John Wiley & Sons. 1908.

The first edition of this laboratory manual was issued in 1904. Its author had set for himself the task of selecting for American students only such exercises as are typical, describing these in the clearest way possible, giving all reasonable discussion of theory and directions for work, and saving the student the labor of searching out his needs in such volumes as Ostwald's "Physiko-Chemische Messungen" and Traube's "Physikalisch-Chemische Methode." These must continue to be standard authorities, but with such wealth of detail and so many references to the German literature of the subject as to be often discouraging to the student who is not already well advanced.

While physical chemistry is now fairly differentiated as an individual branch of physical science, a laboratory manual on this subject is necessarily restricted in range, and the demand for it can never be large. Dr. Getman's aptness in clear statement and good arrangement is manifest, even without more than a cursory examination of the book. The best evidence that he was successful in giving satisfaction to students of his favorite subject is the unexpected discovery that a new

edition is demanded within less than four years. This edition is slightly enlarged to the extent of about forty pages. A short chapter on thermostats has been inserted, devoted chiefly to the toluene regulator for temperatures both above and below the ordinary laboratory temperature. The chapters on electric conductivity and electromotive force have been enlarged, as are also those on solubility and chemical dynamics. The former short chapter on measurement of dielectric constants has been expanded to include that of radioactivity by use of the microelectroscope and the electrometer. Among the reference tables at the end of the book has been now included one for the calculation of the dissociation constant.

The volume is to be commended to students of physical chemistry and will be quite sure to maintain its character for usefulness that has been already well established.

W. Le Conte Stevens
Washington and Lee University

Mosquito Life: The habits and life cycle of the known mosquitoes of the United States; methods for their control; and keys for easy identification of the species in their various stages. An account based on the investigations of the late James William Dupree, M.D., surgeon general of Louisiana, and upon original observations by the writer. By Evelyn Groesbeck Mitchell, A.B., M.S. (Illustrated.) Pp. xxii + 281; 54 figures, 10 half-tone plates. New York and London, G. P. Putnam's Sons, The Knickerbocker Press. 1907.

The title is long—too long, too comprehensive, and not entirely accurate; for by her own showing a goodly portion of Miss Mitchell's book is based upon the observations of others than Dr. Dupree and herself. A brief and altogether appreciative biographical sketch of Dr. Dupree forms the major portion of the introduction and throughout the book are quotations from Dr. Dupree's notes; the text sometimes forced so as to bring them in fittingly. Indeed the book suffers from too much quotation, and in her anxiety to do justice to authors Miss Mitchell has sometimes lost in continuity of statement.

Nevertheless the book is interesting, on the whole very accurate and as nearly complete as a work on a living topic on which many persons are engaged can ever be. Miss Mitchell has a somewhat racy style, which prevents the book from becoming dull, wherever she herself speaks. For example, in dealing with the "buzzing" she says:

> There is, to the writer, nothing on earth so irritating as the shrill piping and shrieking right in one's ear just as one is comfortably drifting off into peaceful slumber. It rouses one up like a fire alarm. The victim snatenes wildly at the air, thinking unutterableness, with the general result of a self-inflicted thumped head and the escape of the tiny offender.

For a book which makes a popular appeal the writer gives a surprising amount of strictly technical information. The chapters are arranged so as to bring out even the details of structure in all stages and the habits of the insects are elaborated at considerable length. In the life histories there is much detail and some of it, in the nature of breeding records, seems rather out of place.

In dealing with structures the author is at her best and speaks from personal knowledge; her drawings in illustration are good, and her comments on the bearing and importance of the structures are usually justified. As to the classification, that is in so chaotic a condition at the present time that no criticism is justifiable. Miss Mitchell follows Coquillett in general, and Mr. Coquillett is at least good authority.

An important feature in a book of this kind is the discussion of the relation of mosquitoes to disease and that is up-to-date and in a general way adequate. There is nothing new or original, the quotations from Dr. Dupree adding little, if at all, to our knowledge, though they do bring out the close connection of the Doctor's work with the yellow-fever investigations. The discussion, in the appendix, on Mosquitoes and Leprosy is inconclusive, and might have been omitted without loss.

The chapter on collecting and laboratory

methods is good and contains suggestions that are most useful to all who have to do with these little pests. The discussion of mosquito remedies and enemies brings together the usual recommendations in concise form, and nothing is added by the author from personal experience.

Chapter XI., containing identification keys and a systematic list, covers sixty pages and is a most useful and ingenious production. The differences in habits and life cycle between the species of mosquitoes are so great and so radical that before practical work can be intelligently done it is absolutely necessary to know what species is really in fault. Many hundreds of dollars have, in the past, been wasted and many a mosquito campaign has in the past ended in failure, simply because the measures adopted failed to reach the species really in fault. These tables will at least help in the attempt to identify the pestiferous types.

For health inspectors, for those interested in sanitation generally and for physicians this book will be especially useful.

There is a rather scanty bibliography and a satisfactory index, in which the illustrations are separately referred to. As to the illustrations, those of the adults are rather disappointing. It seems to be exceedingly difficult to get a really characteristic representation of an adult mosquito and Miss Mitchell has not succeeded any better than others. Some of the illustrations of eggs and of structural details are excellent.

On the whole this is a very useful book: with plenty of faults and an abundance of points that might be criticized if criticism is fault finding; but altogether considered it is commendable. John B. Smith

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for May opens with an article by A. E. Verrill on "Geographical Distribution; Origin of the Bermuda Decapod Fauna," which is considered an offshoot, mainly by accidental migration, from the West Indian fauna. Incidentally is suggested the desirability of introducing new species of crustacea to serve as food for fishes. Charles T. Brues discusses "The Interpretation of Certain Tropisms of Insects," concluding that we can not make satisfactory progress in interpreting the behavior of insects studied in the laboratory without careful reference to their behavior in nature. The third paper, on "The Evolution of Tertiary Mammals, and the Importance of their Migrations," deals with the Miocene Epoch. J. F. McClendon considers "Xerophytic Adaptations of Leaf Structure in Yuccas, Agaves and Nolinas." Francis B. Sumner gives a summary of the work of the season of 1907, at the Biological Laboratory of the Bureau of Fisheries at Woods Hole, Mass. Finally, Gertrude C. and Charles B. Davenport treat of the "Heredity of Hair-form in Man," showing what, under various conditions, are the chances of children having straight, curly or wavy hair. There is a detailed review of half a score of papers on crinoids by A. H. Clark, and a capital summary, by H. S. Jennings, of recent works on animal behavior.

Bird-Lore for May–June has articles on "A Family of Barred Owls," by W. C. Clarke; "The Brown Thrasher," by Charles E. Heil; "A Bittern Study," by Agnes M. Learned; "The Nesting Habits of Henslow's Sparrow," by E. S. Woodruff, and the fourth paper on "The Migration of Flycatchers," by W. W. Cooke. There are many illustrations and many notes. The report of the Audubon Societies shows continued progress and notes two new bird reservations, at Tortugas Keys and Fort Niabrara.

The *Bulletin of the Charleston Museum* for May contains articles on the "Preparation of Museum Exhibits" and on "The Snowy Heron in South Carolina." This species, as the result of protection, has begun to reestablish itself on the South Carolina coast, and one rookery contained about one hundred birds, another at least two hundred, besides many of other species.

A recent number of Smithsonian Miscellaneous Collections is devoted to a paper by C. W. Gilmore on "Smithsonian Explorations in Alaska in 1907 in Search of Pleistocene

Vertebrates" and especially of the mammoth. Mr. Gilmore notes the conditions under which the fossils occur and presents an extremely clear and convincing suggestion as to how the Siberian mammoths became imbedded in ice, a suggestion that calls for no sudden and widespread glaciation and no great beds or ponds of ice. Mr. Gilmore gives a summary of our knowledge of the Pleistocene mammals of Alaska and the localities where they were found, and gives the particulars of the finding of two teeth of the mastodon near Dawson.

In *The Museums Journal* of Great Britain for May, Professor Geddes discusses "The Museum and the City—A Practical Proposal," to interest the public by devoting special attention to illustrating by maps, models and documents the past history of a city and suggest plans for its future improvement. W. B. Barton has "Thoughts on the Equipment of an Art Gallery and Museum" and S. L. Moseley has some notes on "Preserving Plants in Natural Form."

NOTES ON ENTOMOLOGY

The recent parts of Wytsman's "Genera Insectorum" include the hymenopterous family Trigonaloidæ (fascicle 61) by W. A. Schulz, 24 pp., 3 pls. The author has been fortunate in examining nearly all of the available material in this small family, so that all but three species are placed in the system. A number of new genera are established, mostly at the expense of *Trigonalys*. Fascicle 62 is by Dr. Schmiedeknecht on the parasitic Hymenoptera of the subfamily Pimplinæ, 120 pp., 2 pls. The author adopts the usual tribes, but the arrangement of genera is quite different from that of Ashmead. He makes no new genera, but accepts most of those of Ashmead; however he drops many of Förster's genera. Over 1,500 species are catalogued, of which 340 are in the genus *Pimpla*. Fascicle 63 is on a small group of tropical butterflies, the subfamily Dioninæ of the family Nymphalidæ. H. Stichel is the author, 38 pp., 3 pls. Fascicle 64, a ponderous volume of 487 pages, treats of the tiny beetles of the family Pselaphidæ. The author is A. Raffray, who has devoted his whole attention for many years to these insects. Over 3,000 species are arranged in the 452 genera. There are nine plates, three exhibiting the structural details, and the others show about 80 species, drawn by the author. M. Raffray considers that the 3,000 known species are not one third of the existing forms.

The British Museum has long been considered the greatest in the world. Recently it has published an account of its collection.[1] There are lists of the accessions for each year, the number of species and specimens in each order, and the number of boxes for each family. The number of types in each accession is often mentioned, and the persons who revised and arranged each group. The entire number of insects (1904) was 1,018,000 specimens. By orders as follows:

	Specimens	Named Species
Lepidoptera	355,767	41,210
Coleoptera	398,000	67,300
Hymenoptera	132,000	19,600
Hemiptera	57,650	11,700
Diptera	46,900	7,377
Orthoptera	18,800	3,900
Neuroptera	9,056	1,864
Aptera	140	21

The largest collection ever received was the famous Bowring collection of Coleoptera, 230,000 specimens; the next, Stephens general collection, 90,000 specimens; the third, 51,130 Lepidoptera of the Leech collection; the fourth, 45,000 Coleoptera, with over 3,000 types from the Pascoe collection.

Meigen's first work, a classification of flies, has been one of the rarest of entomological publications. Owing to this and to the fact that Meigen himself abandoned them, the genera there presented have rarely been accepted, but recourse was taken to later and more extensive works of this author. Dr. F. Hendel has now republished the paper, with numerous commentaries and references under

[1] "The History of the Collections contained in the Natural History Departments of the British Museum," 2 vols., 1905–7. Insecta, Vol. II., pp. 550–653.

each genus to its equivalent in Meigen's paper in Illiger's Magazine of 1803.[2] Now being available to all, the paper will doubtless kindle many nomenclatorial controversies. According to Hendel, there will be changes in 47 generic names. It would be of great advantage to entomologists, if others, who have access to rare papers, would follow the example of Dr. Hendel and republish them.

MR. R. SHELFORD has described a strange new genus of Diptera,[3] which shows still more than its allies a deceptive resemblance to the cockroaches. The creature is wingless, with deflected head, small eyes, no ocelli, an enlarged globular basal antennal joint, reduced mouth parts, flattened femora, no tarsal pulvilli, and the venter of the abdomen shows no segmentation. It comes from Africa, but nothing further is known about its occurrence.

THE third and concluding part of the Monograph of the Phasmidæ or stick insects has been issued.[4] This part contains the tribes Phibalosomini, Acrophyllini and Necrosciini, and is all by Redtenbacher. There are a great many new species described from his own collection, or from continental museums. Unfortunately he has omitted many species described in the last few years by American writers. The plates, by the author, well represent the remarkable structures of these marvels of insect life.

MR. V. E. SHELFORD, who for several years has been gathering ethologic material on the tiger beetles, has published the first of a series of articles upon this attractive group of insects.[5] There are notes on the habits of various species occurring in the vicinity of Chicago. The life history is given of *C. purpurea*, and more or less completely for *C. cuprascens, C. lepida, C. punctulata, C. sexguttata, C. hirticollis, C. scutellaris, C. tranquebarica, C. duodecimguttata, C. repanda, C. generosa* and *C. limbalis*. The plates show the larvæ, their burrows, the pupal cell, and the head and prothorax of the larvæ of the species; the position of the bristles on these parts furnish good distinguishing characters.

OF all our families of Homoptera the Fulgoridæ are perhaps the least known. Several years ago Mr. E. P. Van Duzee studied one group of them, and lately he has taken up some of the larger forms.[6] Descriptions are given of many new species from various parts of the United States, and tables to the subfamilies, several genera and some of the species. The same author, as the result of a brief trip to the island of Jamaica, has published a list of the Hemiptera of that island.[7] Nearly fifty species are described as new in the list of over 230 collected on the trip. Dr. O. M. Reuter has elsewhere described some of the Capsidæ taken by Mr. Van Duzee in Jamaica. And in the same society Mr. Van Duzee has published a comprehensive review of our tree-hoppers.[8] Synoptic tables are given to the genera and usually to the species. The author has placed more reliance upon the shape of the prothorax than many writers. It is hoped that the paper will lead to a monographic treatment in the near future.

DR. W. M. WHEELER has contributed two more articles to the ant fauna of our country. One, a revision of the Myrmecocysti[9] or

[2] "Nouvelle classification des mouches à deux ailes (Diptera L.) d'apres un plan tout nouveau," par J. G. Meigen, Paris, an VIII. (1800). Mit einem Kommentar herausgeben von F. Hendel, *Verh. zool.-bot. Ges. Wien*, 1908, pp. 43–69.

[3] "*Ænigmatistes africanus*, a New Genus and Species of Diptera," *Journ. Linn. Soc. Lond. Zool.*, XXX., 150–155, 1 pl., 1908.

[4] "Die Insektenfamilie der Phasmiden," Leipzig, 1908, pp. 341–589; 12 pls., folio; by K. Brunner v. Wattenwyl and J. Redtenbacher.

[5] "Life Histories and Larval Habits of the Tiger-beetles (Cicindelidæ)," *Journ. Linn. Soc. Lond. Zool.*, XXX., pp. 157–184, 4 pls., 1908.

[6] "Studies in North American Fulgoridæ," *Proc. Acad. Nat. Sci. Phil.*, f. 1907, pp. 467–498, 1908.

[7] "Notes on Jamaican Hemiptera," *Bull. Buffalo Soc. Nat. Sci.*, VIII. (No. 5), 79 pp., 1907.

[8] "Studies in North American Membracidæ," *Bull. Buffalo Soc. Nat. Sci.*, IX., pp. 29–129, 2 pls., 1908.

[9] "Honey Ants, with a Revision of the American Myrmecocysti," *Bull. Amer. Mus. Nat. Hist.*, XXIV., pp. 345–397, 1908, 28 figs.

"honey ants," is especially attractive because of the accounts of the habits of all the known honey ants of the world. These honey ants have one form in which the abdomen is swollen by stored honey. Such forms occur in six widely separated genera. Our *Myrmecocystus* belong to two species, each with several subspecies and varieties; they inhabit the arid regions of Mexico and the southwestern United States. The other paper is an annotated list of the ants of Texas, New Mexico, and Arizona.[10] More ants occur in this region than in all the rest of the United States; 101 species being recorded in this first paper, 41 of which are in the genus *Pheidole*. There are many notes on the habits of the various species, and descriptions of several new forms.

Col. T. L. Casey has again published on the darkling beetles.[11] This time on the Coniontinæ, a group of moderate-sized insects found in the western states. About two hundred species are treated in synoptic form, more than half are described as new, and almost all are recorded from but one locality. Several new genera are based on species closely allied to *Eusattus* and *Coniontis*.

Making its initial appearance in the familiar garb of the French society comes the *Bulletin de la Société Entomologique d'Egypte*. It is published at Cairo in French, and under French auspices. Fascicle 1 has forty pages, and among other articles is one on the beetles found in the Egyptian mummies.

Nathan Banks

SPECIAL ARTICLES

REGIONS OF MAXIMUM IONIZATION DUE TO GAMMA RADIATION

1. I have recently standardized the fog chamber by the aid of Thomson's electron. The method (as will be shown elsewhere) is not only expeditious, but leads by inversion, when my old values of the nucleations of the coronas are inserted, to values of e which agree with Thomson's and other estimates. This affords an incidental check on the broader bearings of the work. Thus a series of rough tests made in this way showed $e \times 10^{10}$ to lie between 3 and 4 els. units, agreeing closely enough with the accepted values to prove that both the positive and the negative ions are captured in my fog chambers, even at very high nucleations (500,000 per cu. cm.).

2. The experiments themselves run smoothly and take but a few minutes each; but there is an *inherent* difficulty involved in the interpretation of the distributions of ionization observed in the fog chamber. The radium (10 mg., 100,000, contained in a small thin sealed glass tube) is introduced into the inside of a cylindrical fog chamber, by aid of an aluminum tube (walls 1 mm. thick and about one quarter of an inch in diameter), thrust axially from one end to the other of the horizontal chamber. The inner end of the aluminum tube is thoroughly sealed; the other end lies quite outside the fog chamber, is open, and serves for the introduction of the radium tube. In this way the latter may be moved axially from the glass end of the fog chamber on the right of the observer, to the metal cap which closes the fog chamber on the left.

When the radium is successively placed at distances of about 11 cm. apart within the available 45 cm. the length of the fog chamber, the maximum nucleation (ionization) coincides with the position of the radium when both are near the glass end of the chamber (12 cm. in diameter). The nucleation then falls off rapidly and at first uniformly from the glass end to the metal end, where the coronas are strikingly smaller and the nucleation less than one half of that observed at the glass end. Considered alone, this would appear like the natural effect of an increasing distance from the source, except that the coronas near the distant end approach a constant diameter.

When the radium is moved about 12 cm.

[10] "The Ants of Texas, New Mexico and Arizona," *Bull. Amer. Mus. Nat. Hist.*, XXIV., pp. 399–485, 1908, 2 pls., Part I.

[11] "A Revision of the Tenebrionid Subfamily Coniontinæ," *Proc. Wash. Acad. Sci.*, X., pp. 51–166, 1908.

(one quarter of the length of the fog chamber) from the glass end toward the metal end, the maximum nucleation, moving at a greater rate toward the brass end, has already outstripped the position of the radium and now lies near the middle of the chamber. The coronas and the corresponding nucleations, therefore, fall off rapidly toward both ends. In other words, the *maximum nucleation is seen where there is no radium.*

On moving the radium to the middle of the chamber, the position of the maximum nucleation coincides with the brass end, over 20 cm. beyond the radium. The coronas now fall off from left to right, to a uniform size near the glass end of the chamber, the ratio of the extreme nucleations being at least 200,000 to 100,000 per cubic centimeter in the cases examined. Finally, when the radium is placed in the brass cap of the chamber, the maximum still lies there and the nucleation falls off toward the glass end; but all nucleations are reduced throughout about one half.

It is clear that the two ends of the chamber behave differently. There must, therefore, be some sort of conflict (to use a word that has not been preempted) between the primary and secondary radiations which issue from the ends and other parts of the chamber. The solid walls both contribute nucleation; the glass wall most when close (a few cm.) to the radium, the metal wall at a greater distance (20 cm.) from the radium; but no simple hypothesis of the known properties of the rays will account for the occurrence and location of regions of maximum nucleation, nor for the high nucleation ratios specified. Moreover, plates of lead placed outside over the glass end of the chamber to modify the secondary radiation are quite without effect. Covering the aluminum tube with a thick lead pipe, the phenomenon is slightly reduced in magnitude, but not in character. It follows that the gamma rays are chiefly concerned.

In a region of maximum nucleation there must either be a larger rate of production or a smaller coefficient of decay. The latter may be expected if in the region of maximum nucleation the ions have largely the same sign. The best conception of the phenomenon which I can form at present is thus an explanation in terms of Bragg's[1] theory of neutral pairs for the gamma rays. As such, a region of primary rays may be regarded as devoid of nucleation. On impact, however, these paired rays separate into secondary cathode rays and alpha rays, returning with unequal swiftness from both ends of the fog chamber. In order to exist as separate condensation nuclei, they must, therefore, travel over a certain distance to be recognized as distinct particles by the fog chamber, the distance depending on the intensity of the impact of the gamma rays; depending, therefore, on the buffer, on the strength and distance of the radium from the buffer. In the above experiment this function is performed by the ends of the fog chamber. In case of very weak radium, a minimum of nucleation in the middle of the chamber, and coinciding in position with the radium, was actually obtained, in contrast with the central maxima for the strong radiations, as described above. Possibly the frequent occurrence of the ratio of 2 to 1 between the maximum and minimum nucleations may be similarly interpreted; but much further work is necessary before any definite conclusions can be reached. I am now constructing a chamber about 1 meter long, with the object of ascertaining whether more than one maximum of nucleation is producible; in other words, to interpret the stationary wave resemblances of the phenomenon.

3. A final element of interest is the behavior of the axial aluminum tube after the radium (in small sealed glass or aluminum tubes) has been removed. The internally sealed aluminum tube is distinctly radioactive for several hours, even though gamma rays alone have passed through it. The activity vanishes gradually, and more quickly if the ions are continually precipitated by exhaustion. The behavior of this residual nucleation is very peculiar; if the aluminum tube is pushed into the fog chamber, axially, from the glass end as far as the middle, the

[1] See *Phil. Mag.*, May, 1908.

part of the chamber around the tube shows strong coronas on exhaustion while the other half (toward the brass cap) is blank. Something, consisting of very slow-moving particles, gradually diffuses radially out of the aluminum tube. Of course it is difficult to deny with assurance that merest traces of emanation decaying within the aluminum tube may not possibly account for the activity; but what is remarkable in any case is the existence side by side of a region with nucleation and a region without it, in the absence of anything like a partition. The fog chamber itself must at all times be scrupulously free from infection such as an emanation would produce, and anything of this kind is at once detected.

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A NEW METHOD OF ENUMERATING BACTERIA IN AIR

THE development of accurate bacteriological methods for the examination of air has not attracted wide attention in recent years; and this branch of bacteriology is far behind the related subject of water bacteriology in its technique and interpretation.

Bacteriological examinations of air have been carried out by most observers in one of two ways, without much attempt at critical control. The most primitive method consists in the simple exposure of plates of nutrient gelatin or agar for a more or less indefinite period. The colonies developing, correspond in a rough way to the bacterial flora of the air above. The method, however, can not be considered a quantitative one, since the number of bacteria which fall on the plate is not related to any particular volume of air and must vary with all sorts of environmental conditions. Nevertheless, this method is still used in many investigations in which quantitative results would be valuable; as in the important work of Major Horrocks on the presence of bacteria derived from sewage in ventilating pipes, drains, inspection chambers and sewers.[1]

The other method in common use is a modification of the sand-filter method of Pasteur and Petri. It involves the filtration through asbestos, sand, sugar, etc., of a measured volume of air; the washing of the filtering material with sterile water; and the plating of aliquot portions of the wash water in the usual way. Pasteur used asbestos for his filtering material; Sedgwick and Tucker recommended finely powdered sugar; and Petri and most recent observers have used sand. Petri pointed out that the sand should be of such fineness as to pass a .5-mm. mesh. In a recent important study of the air of the New York Subway Soper used both the plate method and the sand-filter method. The sand grains used were "about half a millimeter in diameter" and the sand layer 5 cm. deep.[2] In discussing these methods, in another paper, this author said, "as is well known, there is no precise way to determine the numbers of bacteria in air."[3]

I have been engaged for about a year in a study of bacteria in sewer air; and relied at first upon the sand-filter method. The remarkable results, reported by Major Horrocks in the paper to which reference has been made, led me to revise the detail of my technique with considerable care. In the course of the investigation a modified method of air examination was developed which is here reported in the hope that it may be of assistance to others at work on similar lines.

My aim was to combine the quantitative results of sand filtration with the directness and simplicity of the plate method. Hesse did this after a fashion by slowly aspirating air through a long roll-tube the walls of which were covered with melted gelatin. There was, however, a possibility in such an apparatus that bacteria might be drawn through, without settling out on the walls. My method is really a modification of Hesse's with an increase in the size of the culture vessel relative to the sample of air. I use two liter-and-a-half bottles arranged as shown in Fig. 1. On the

[1] *Proceedings of the Royal Society*, Series B, Vol. 79, No. 531, p. 255.

[2] *Technology Quarterly*, XX., 58.

[3] *Journal of Infectious Diseases*, Supplement No. 3, 1907, p. 82.

bottom of each is a layer of nutrient gelatin; and the tubing is adjusted so that a measured volume of air may be drawn through the two bottles in succession, by the action of a water-suction bottle, shown inverted on the right of the figure. In practise I place any desired amount of water, generally one liter, in the suction bottle and by slowly inverting it draw a corresponding volume of air from the bottom of the second culture bottle. The same volume of air passes from the bottom of the first bottle into the top of the second and from the outer air into the top of the first bottle. A known amount of air is thus drawn into the first bottle and the bacteria present settle out and form colonies on the gelatin. The volume of air examined being less than the capacity of either bottle, most of the bacteria remain in the first. A few, which are carried down by direct short currents, are caught in the second bottle. The results of a few examinations made by this method are shown in the table below.

The number of bacteria reaching the second bottle is evidently small, in most cases less than 10 per cent., and the number lost by being drawn through the second bottle must be negligible. With the exception of the possibility that bacteria may settle on the walls of the bottles, the method should give a complete account of all bacteria present which will grow under ordinary conditions of cultivation.

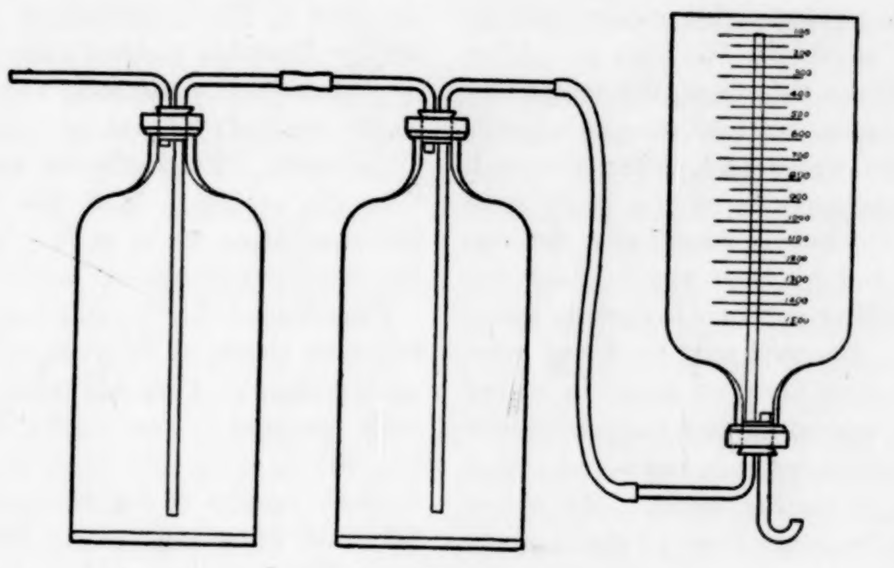

FIG. 1.

AIR EXAMINATION BY CULTURE BOTTLE METHOD

Air	Sample, c.c.	Colonies, First Bottle	Colonies, Second Bottle	Bacteria per Liter
Normal street air.	1,500	4	0	3
Air above foaming soapy emulsion of *B. prodigiosus.*	1,000	1	0	1
	1,000	1	1	2
	1,000	1	0	1
	1,000	3	0	3
	1,000	1	0	1
Air sprayed with suspension of *B. coli.*	100	73	1	740
	100	984	91	10,750
	100	394	69	4,630
Air sprayed with suspension of *B. prodigiosus.*	100	492	3	4,950
	100	320	34	3,540
	100	1,188	120	13,080

The culture-bottle method was devised primarily as a check on the sand filter method; and two types of sand filters were used for comparison. The first was the classic Sedgwick-Tucker apparatus, which consists of a glass tube 15 cm. long and 4 cm. in diameter, opening at one end into a smaller tube 10 cm. long and .5 cm. in diameter. A layer of 5 cm. of sand was supported in the small tube by wire gauze. A measured amount of air was drawn through, entering the larger tube and passing out through the sand. The sand, with the bacteria filtered out, was shaken down into the large tube, melted gelatin was added, and

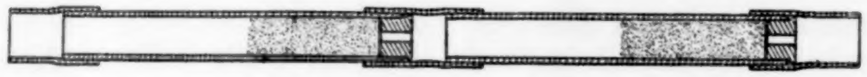

Fig. 2.

by rolling the tube on ice the gelatin with the sand and bacteria was cooled on its inner surface. The sand used in this filter was between .5 mm. and 1 mm. in diameter.

The other type of filter tested consisted of two short tubes, 1.5 cm. in diameter, arranged in tandem, each containing 2.5 cm. of fine sand, between .1 mm. and .3 mm. in diameter. The sand in each tube was supported by bolting cloth on a perforated rubber stopper and the tubes were connected by rubber tubing. The apparatus is shown in Fig. 2. After drawing air through this filter, the sand from each tube was shaken out into ten cubic centimeters of sterile water and, after thorough agitation, aliquot portions of the water were plated. This method is essentially the one used by Soper and by most recent observers.

Each of these filter methods is open to possibilities of error. Bacteria may be drawn completely through the filtering layer in either case; and in the second method there is danger that bacteria filtered out may not be separated from the sand or bolting cloth. My object was to find out the magnitude of these errors by direct comparison with the culture-bottle method. For this purpose a number of examinations were made, of normal air, and of air artificially infected with bacteria by spraying with emulsified cultures. With the filtration method samples of 750 c.c. to 1,500 c.c. were slowly drawn through the sand, the filtration occupying from two to three minutes. With the culture bottles, samples of 100 c.c. were generally used and the air was drawn in more rapidly. The general results obtained may be shown best by quoting a few typical experiments in detail.

Experiment III.—Examinations of air of a city street on a winter day. Four successive samples taken at intervals of fifteen minutes showed: (1) 3 bacteria per liter, by culture-bottle method; (2) 17 bacteria per liter by filtration method (fine sand); (3) 23 bacteria per liter by filtration method (fine sand); (4) 94 bacteria per liter by filtration method (fine sand). Apparently the number of bacteria in the air was increasing during this experiment; but the results by the two methods are concordant.

Experiment IV.—A suspension of a culture of *B. coli* was sprayed into a box and five samples taken at intervals of about ten minutes. The results were as follows: (1) 2,640 per liter by filtration method (fine sand); (2) 100 by filtration method (fine sand); (3) 740 by culture-bottle method; (4) 40 by culture-bottle method; (5) 0 by sand-filter method (fine sand). Evidently the bacteria were settling out rapidly. With the exception of the low sand-filter count in No. 2 the results of the two methods check fairly well.

Experiment V.—*B. coli* was sprayed into a box four times, at intervals of about ten minutes, a sample of the air being examined after each spraying. The results were as follows: (1) 175 bacteria per liter, by sand filtration (coarse sand); (2) 4,300 per liter by sand filtration (fine sand); (3) 4,000 per liter by sand filtration (fine sand); (4) 10,750 per liter by culture-bottle method. Very probably the repeated spraying more than balanced the settling out and the number of bacteria in the air of the box actually increased. The first result with the coarse sand seems low, however.

Experiment VI.—*B. prodigiosus* was sprayed into a box three times. The first two samples were examined after the first spraying, the third and fourth samples after the second and third sprayings, respectively. Results: (1) 15,000 bacteria per liter, by sand filtration (fine sand); (2) 14,000 per liter by culture bottle method; (3) 5,300 per liter by sand filtration (coarse sand); (4) 14,000 per liter by sand filtration (fine sand). Again the filtration method checked with the culture bottle method when fine sand was used, but gave low results with the coarse sand.

These experiments, and others of the same sort, seemed to indicate that sand filtration gives reasonably accurate results if the sand used be as fine as .3 mm. The crucial test of this point, however, must be made by drawing a given sample of air through sand filters and a culture bottle, so arranged in tandem that the bacteria which pass the sand shall be collected in the bottle. The table below shows a series of such experiments and makes it clear that the efficiency of the filtration method depends upon the size of sand grain employed.

RELATIVE NUMBER OF BACTERIA PASSING THROUGH SAND FILTERS; AND RETAINED IN THEM

Air Examined	Bacteria per Liter Retained in Filter		Bacteria per Liter Passing Filter
	Two 2.5 cm. Layers of .1-.3 mm. Sand	One 5 cm. Layer of .5-1 mm. Sand	
Suspension, *B. prodigiosus*.	100		2
Street air.	94		1
Suspension, *B. coli*.	2,640		12
" "		175	304
" "	4,000		37
Suspension, *B. prodigiosus*.		1,700	3,500
Suspension, *B. prodigiosus*.	14,000		2,400
Suspension, *B. coli*.	40		12
" "	90		15
" "		165	105

In seven tests with tandem sand filters, each containing 2.5 cm. of sand, with grains between .1 and .3 in diameter, the bacteria passing the sand were—once 30 per cent. of the number retained by the sand, twice 17 per cent., once 2 per cent. and three times 1 per cent. or less. On the other hand, in three tests with the Sedgwick-Tucker apparatus holding a single layer of sand, 2 cm. deep with grains between .5 mm. and 1.0 mm., nearly half the bacteria present passed the sand in one case and about two thirds escaped in the other two instances.

It seems clear that sand over .5 mm. in diameter is inadequate for filtering out bacteria. On the other hand, a sand finer than .3 mm. is generally efficient though not wholly reliable, since at times it allows a considerable proportion of bacteria to pass. This is not remarkable when the relative size of sand and bacteria is considered.

It is, of course, obvious that sand can not operate in the removal of bacteria by any process which can properly be called straining. In an editorial discussion of the removal of fine particles from water the *Engineering News* (LIX., 344) has described the phenomenon as "adhesion"; and the term deserves general acceptance in this connection. The size of the sand must affect the removal of fine particles in two ways. First, in a given depth, the number of surface contacts, which permit adhesion, must vary inversely with the size of the particles. Second, the velocity of flow, which tends to tear off adhering particles, must, under given conditions, increase with the size of the particles. Coarse sand might, therefore, be used with success by filtering through a deeper layer and by cutting down the rate of flow. It is simpler, however, to use sand sufficiently fine to regulate the rate of filtration automatically.

On the whole, the culture-bottle method seems to offer a more accurate procedure for bacterial examination of air than any yet available. The sand-filter method is fairly accurate as a rule, but occasionally gives low results. The filter method is more convenient than the culture bottle method for examinations outside the laboratory, since for the latter it is necessary to carry two 1,500 c.c. bottles for each examination. Aside from this difficulty of transportation, however, the technique of the culture-bottle method is to be preferred. Bottles are easier to prepare and to sterilize than sand filters and the actual examination is simplified by the omission of sand washing and subsequent plating.

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SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES, SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY

A meeting of the Section of Astronomy, Physics and Chemistry was held at the Museum of Natural History on Monday, January 20, at 8:15 P.M.,

Professor D. W. Hering in the chair. Professors Lamb, Rosanoff and Breithut read a paper on "A New Method of Measuring Partial Vapor Pressures in Binary Mixtures."

On Monday, March 16, Professor W. Campbell read some "Notes on Metallography applied to Engineering." The methods of preparing specimens, development of structure, microscopic examination and photographing the specimen were briefly reviewed. The structure of metals, ingotism and grain structure, the effects of strain and of annealing were demonstrated and the constitution of alloys, mattes, speisses, etc., taken up. The carbon-iron series, the graphite-austenite and cementite-austenite groups were discussed and illustrated. Examples of structure were given; wrought iron *vs.* low carbon steel, good and bad material; working and annealing of medium carbon steel; rails and examples of their failure; steel tyres and shelling out; the structure of hypereutectic steels and their change with heat treatment; cast iron, gray, mottled, white, spiegeleisen; cementation and blister steel; malleabilizing and the formation of temper carbon.

The application of metallography to economic geology was shown by demonstrating the paragenesis of certain mixed sulphide ores, of silver ores from Cobalt, Ont., of the Butte copper ores, of typical "enrichment zones." The constitution of so-called nickeliferous pyrrhotites and of certain complex opaque minerals was shown. Many lantern slides were used to illustrate the paper.

A sectional meeting was held on Monday, May 18. Dr. J. P. Simmons presented a "Note on a Curious Effect produced by the Explosion of Detonating Gas." When a mixture of oxygen and hydrogen is exploded in a tube, the inside of which is coated with a thin layer of water, perfect rings are formed. The same phenomenon has been noticed when the same kind of a gas mixture is exploded in a tube, the inside of which is coated with a thin layer of wax. This is a heating effect, since the rings formed in the tube covered with wax are made apparent by the melting of the latter substance. This periodic heating is probably due to compressions arising from either sound or explosion waves.

W. Campbell and R. F. Böhler read a paper on the heat treatment of carbon tool steels. The various constituents of unhardened and hardened high carbon steels were first classified, cementite, pearlite, ferrite, graphite, austenite, martensite, troostite, osmondite and sorbite, and the views of the different authorities on their constitution given in tabular form. The plan of study embraced (1) heating to various temperatures and (*a*) slow cooling, (*b*) quenching, (*c*) tempering; (2) the effects of forging temperature and quenching temperature, to see whether the structure gave any evidence whether overheating had taken place during forging at the works of the manufacturer or during reheating for hardening at the user's, in the case of faulty material; also whether this persisted after tempering. Only the maximum forging temperature left any traces after quenching and this was much above that used in practise. Tables and curves showing variation of physical properties with heat-treatment were given, and the various structures illustrated by numerous lantern slides.

Professor Charles L. Poor presented two papers by title, (1) "An Investigation on the Figure of the Sun and of Possible Variations in its Size and Shape," (2) "The Photoheliometer."

WILLIAM CAMPBELL,
Secretary

COLUMBIA UNIVERSITY

THE CHEMICAL SOCIETY OF WASHINGTON

AT the 183d meeting of the Chemical Society of Washington, held at the Cosmos Club, May 14, 1908, the following papers were presented: "Influence of Fine Grinding on the Water and Ferrous Iron Content of Minerals and Rocks," by W. F. Hillebrand, and "Technical Value of Wood Turpentine," by F. P. Veitch.

Mr. Bailey Willis, of the Washington Academy of Science, addressed the society in regard to a proposed scientific weekly. The following resolution was then adopted:

Resolved, That it is the sense of the society that the new journal is desirable and, further, that it will be welcomed by this society.

The meeting was presided over by President Joseph S. Chamberlain, and the attendance was 48. President Bogert also addressed the society on problems of general interest to the members of the Chemical Society.

A special meeting of the society was held at the George Washington University Lecture Hall on May 9, 1908. President Chamberlain introduced Dr. C. A. Ernst, the speaker of the evening, who gave an address on "Viscose and Artificial Silk." The lecturer showed many samples of artificial silk, and explained the process carried on at the Genasco Silk Works of Lansdowne, Pa. The attendance was 65.

J. A. LECLERC,
Secretary